Can Liquidity Events Explain The Low-Short-Interest Puzzle? Implications From The Options Market*

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This paper argues that liquidity events in short selling, such as short squeezes, margin calls, and stock specialness, may be an important part of short-selling constraints. We gauge the importance of liquidity events by utilizing a market-based measure, which is the cost of using options to limit the potential losses of short selling. Our approach circumvents the typical endogeneity problem in directly estimating the magnitude of short-sale constraints. We show that the costs of insurance against liquidity events exceed the abnormal profits of short positions. Our results therefore suggest that liquidity events can impose substantial costs on short sellers, and may thus explain the low-short-interest puzzle.

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Abstract

This paper argues that liquidity events in short selling, such as short squeezes, margin calls, and stock specialness, may be an important part of short-selling constraints. We gauge the importance of liquidity events by utilizing a market-based measure, which is the cost of using options to limit the potential losses of short selling. Our approach circumvents the typical endogeneity problem in directly estimating the magnitude of short-sale constraints. We show that the costs of insurance against liquidity events exceed the abnormal profits of short positions. Our results therefore suggest that liquidity events can impose substantial costs on short sellers, and may thus explain the low-short-interest puzzle.

1 Introduction

Over the past few decades, the financial literature has documented a number of asset-pricing anomalies. It has been argued that the persistence of some of these anomalies can be explained by high short-sale costs. Nevertheless, there has recently been growing evidence that short-selling costs are in fact generally low (see, e.g., D'Avolio, 2002, and Geczy, Musto, and Reed, 2002). It is therefore puzzling that investors do not short sell stocks in larger amounts and arbitrage away these apparent asset-pricing anomalies (see, e.g., Lamont and Stein, 2004, Rubinstein, 2004, and Asquith, Pathak, and Ritter, 2005).

Some studies, such as Shleifer and Vishny (1997), Duffie, Gârleanu, and Pedersen (2002), Liu and Longstaff (2004), and Battalio and Schultz (2005), point out that liquidity events in short selling, such as short squeezes, margin calls, and stock specialness, can potentially impose substantial costs on short sellers. If these events occur concurrently with stock-price increases, the short sellers typically must either add capital to their short position or close it at a loss. Furthermore, the lack of liquidity or immediacy in the stock market could induce additional costs in the attempt to close the short position. The low-short-interest puzzle can therefore be explained by the costs involving liquidity events if these costs are substantially large. Yet, it is difficult to explicitly measure these costs due to the endogeneity involved: investors may perceive a high likelihood of incurring considerable costs during liquidity events in the future, and thus avoid short selling. As a result, liquidity events in short selling become rare events. It therefore remains difficult to empirically establish a clear conclusion with respect to whether liquidity events can explain the short-interest puzzle.

The contribution of this paper is that it gauges the impact of liquidity events by using a market-based measure from the options market. The advantage of options is that they allow short sellers to establish their position with a maximum bound on possible losses, which could prove to be especially important during a liquidity event. The cost of adding such a bound using options can therefore be viewed as a market-based measure of the cost of insurance against liquidity events in short selling. Our analysis indicates that this cost of insurance exceeds the abnormal profits of short positions. Therefore, our empirical evidence is consistent with the hypothesis that liquidity events explain the low-short-interest puzzle.

The various scenarios under which liquidity events in short-selling positions may occur stem from the institutional features involving the short-selling activity: To short sell a stock, the short seller must first borrow the stock and place a collateral; the stock lender receives a loan fee and has the right to call back the stock at any point in time; and, the short seller must establish a margin account subject to minimum margin requirements. The call-back feature may force the short seller to close the position in the event of a stock recall. These situations are often referred to as "short squeezes" (see Duffie, Gârleanu, and Pedersen, 2002). The margin requirements may induce margin calls during sharp increases in stock price. Finally, the stock loan fee could potentially become very high, the situations about which the stock is said to be on "special". If these liquidity events occur in conjunction with stock-price increases then the short seller may be forced to close the short position at a loss. Note that if short sellers are highly capitalized long-term investors, then margin calls or stock specialness do not necessarily force short sellers out of their position. Otherwise, the cost of carrying the short position in the event of margin calls or stock specialness may effectively force the short seller to close out a short position even when stock prices are above their fundamental values.

To examine the costs of hedging against these liquidity events, we consider three different ways to short-sell stocks: uncovered-short selling, which is the usual short-selling strategy without using options; covered-short selling, which is a strategy composed of a short position in stocks and a long position in deep-out-of-the-money call options; and a long position in deep-in-the-money put options. As options differ by time-to-maturity and strike price, the call options used for the covered-short selling strategies and the put options used for the long-put strategies are both chosen such that these strategies most resemble the uncovered-short selling strategy. Note that under the put-call parity and the assumption of no transaction costs, the long position in a put option is equivalent to the covered-short selling. Nevertheless, we implement both strategies because the transaction costs of puts and calls may differ in practice, and because put-call parity may not always hold (see, e.g., Kamara and Miller, 1995, and Ofek, Richardson, and Whitelaw, 2004).

To quantify the impact of the costs of insurance on the net profitability of short selling, we apply each of the three above-mentioned short-selling strategies to several existing asset-pricing anomalies. In particular, we create portfolios of uncovered-short, covered-short, and long-put positions on momentum losers, high volatility stocks, and high turnover/short-interest stocks. Our choice of stocks to short-sell is motivated by the existing literature, which documents that portfolios of stocks in these three classes earn negative abnormal returns with respect to the Fama and French (1993) three factors. Jegadeesh and Titman (1993, 2001) among many other papers document the abnormal negative returns of momentum losers. Ang, Hodrick, Xing, and Zhang (2005) document the low abnormal returns of stocks with high idiosyncratic volatility. In addition, motivated by the theory developed by Miller (1977), Boehme, Danielson, and Sorescu (2005) document that stocks with high turnover and high short interest earn negative abnormal returns. Our choice of creating portfolios of covered-short and long-put positions implies that we insure each stock in a portfolio against liquidity events, which is consistent with the fact that liquidity events such as short squeezes are idiosyncratic in nature. As a result, the use of portfolio strategies is not meant to mitigate idiosyncratic risk, but rather to increase the precision of the estimation of the abnormal risk-adjusted returns.

Our results suggest that the costs of liquidity events may be an important part of short-selling constraints. Although the open interests of options are generally low, roughly 40% of the NYSE-listed stocks used for our short-selling strategies have options that could be used for the covered-short and long-put strategies. Uncovered-short positions on these optionable stocks display significant abnormal profits ranging from 0.60% to 1.06% per month. Yet when options are used as insurance against liquidity events, i.e. as part of covered-short and long-put strategies, the potential profits vanish because transaction costs in the option markets exceed the abnormal profits of an uncovered-short position. Our results are robust to the choice of options' times-to-maturity and strike prices.

This paper contributes to the rapidly growing literature on the effects of short-selling constraints on stock returns. Closely related to our paper are the studies by Asquith, Pathak, and Ritter (2005), D'Avolio (2002), and Geczy, Musto, and Reed (2002), all of which show that liquidity shocks in short sales are generally rare. Our paper points out the endogeneity of such events, and circumvents this issue by utilizing the options market to indirectly assess the importance of liquidity events. The results also complement papers such as those by Dechow, Hutton, Meulbroek and Sloan (2001), Chen and Singal (2003), Irvine (2005), and Gamboa-Cavazos and Savor (2005), which view the possibility of short-squeezes as a short-sale constraint. Our paper explores this possibility by explicitly quantifying the costs of insurance against short squeezes. In addition, our results are in accord with those reported in Santa-Clara and Saretto (2005) with respect to the large transaction costs of options. Our focus, however, is different, because we analyze long positions on options in the cross-section of firms while Santa-Clara and Saretto (2005) study short positions on index options.[1]

Our paper also relates to a series of studies on the relation of options to short-sale constraints. Figlewski (1981), Figlewski and Webb (1993), and Danielson and Sorescu (2001) study whether options relax short-sale constraints. Our paper complements these studies in that we analyze the possibility of using options to avoid extreme losses in short-sale positions. Lamont and Thaler (2003), Ofek, Richardson, and Whitelaw (2004), and Battalio and Schultz (2005) examine the relation between put-call parity violations and short-sale constraints. Our paper does not address the issue of put-call parity violations, but rather utilizes options to measure the costs of insuring against liquidity events in short-selling. Some of our results on the availability of options are in agreement with those in Lakonishok, Lee, and Poteshman (2003). We focus, however, on different issues because we are specifically interested not only in the availability of options for insuring against liquidity events, but also in the risk-adjusted returns of the short-selling strategies implemented with protective options.

The remainder of this paper is organized as follows. Section 2 describes the various databases used for this study, including short-interest data and options data. Section 3 describes the asset-pricing anomalies considered for the analyses. Section 4 outlines the construction of the different short-sale strategies, the criteria for choosing options, and the calculation of net returns. The results of the analyses are reported in Section 5. Section 6 concludes.

2 Data

This study uses five types of data: short-interest data from the NYSE; options data from the Ivy DB-OptionMetrics; intraday S&P500 options data; daily stock data from CRSP; and intraday stock transaction data from TAQ. The short-interest, stock options, and stock data are merged to build a dataset with a large cross-section of firms.

Short-interest data are downloaded from the NYSE website. The NYSE short-interest data are monthly and contain the open short positions of NYSE-listed securities as of the trading day with settlement on the 15^{th} of each calendar month, or, if the 15^{th} is not a business day, on the last business day before the 15^{th}. We follow Asquith, Pathak, and Ritter (2005) in defining the

[1] Other related works are Diamond and Verrecchia (1987), Senchack and Starks (1993), Reed (2001), Chen, Hong and Stein (2002), Jones and Lamont (2002), Hong and Stein (2003), Ofek and Richardson (2003), Lamont and Stein (2004), Christophe, Ferri and Angel (2004), Cohen, Diether, and Malloy (2005), and Nagel (2005).

variable short interest (SI) as the number of shares short sold divided by the total number of shares outstanding for each firm.

The Ivy DB options database provides end-of-day bid and ask quotes, open interest, trading volume, implied volatility, and option sensitivities for US equity and index options market. The implied volatility and option sensitivities are calculated with the Black and Scholes (1973) model for European options, or the Cox, Ross, and Rubinstein (1979) binomial tree for American options. All options on individual stocks are American. The Ivy DB dataset currently covers the time period from January 4, 1996, until December 31, 2004. The dataset also includes a volatility-surface file that contains the interpolated volatility surface for each security on each day using a kernel-smoothing algorithm. The volatility surface provides the implied volatility for each standardized option with various times-to-maturity and deltas.

To examine the trading activity in options, we select all the options on NYSE-listed stocks with open interest greater than zero from the Ivy DB. Summary statistics of these options are reported in Table 1 and show some stylized facts about the trading activity in the stock-option markets. For example, the open interest of calls is on average larger than that of puts, indicating that for individual stocks, calls seem to be more frequently traded. In addition, both the open-interest-weighted average deltas and moneyness suggest that out-of-the-money options are more liquid than in-the-money options. The average bid-ask spread of options is around 25 cents and because the prices of out-of-the-money options can be small, the relative bid-ask spread is, on average, 45% of the option prices.

Battalio and Schultz (2005) note that the Ivy DB should not be used for the purpose of evaluating put-call parity violations because of problems of nonsynchroneity between the option and stock markets. Our research framework, however, is not subject to this issue for two reasons: First, our study does not analyze put-call parity violations. Second, our analysis involves monthly return strategies, and we therefore apply the standard use of closing prices adopted in the literature. In addition, the average option bid-ask spread relative to the price of the underlying stock reported in Table 1 is consistent with the option transaction cost in Battalio and Schultz (2005). This is important because, as further discussed in Section 4.1, our results depend on the transaction costs in the options market, specifically, the difference between the quoted ask price and bid price of options scaled by the level of the underlying stock price, henceforth referred to as relative spread. The fact that the relative spreads in the Ivy DB are consistent with those in Battalio and Schultz

(2005) justifies our use of the Ivy DB for examination of transaction costs in the options market.

To further certify the suitability of the Ivy DB for our study, we utilize a proprietary dataset of intraday prices of S&P500 index options from January 2, 2001, to December 31, 2002. These data were automatically collected from the CBOE website every 15 minutes during this period. In total, this dataset includes slightly more than 9.4 million observations of S&P500 options with various strike prices and times-to-maturity. We use these data to address the possibility that the intraday bid-ask spreads are different from the closing bid-ask spreads. Table 2 reports the time-series median of the cross-sectional median (per time-to-maturity and moneyness group) of the ratio of the average intraday relative spread from our S&P500 data and the daily closing relative spread of S&P500 options from the Ivy DB. All the ratios are above 91%, indicating that the intraday relative spreads calculated from the CBOE are not significantly lower than the closing relative spreads calculated from the Ivy DB. We therefore conclude that the differences between intraday and closing bid-ask spreads are likely to be immaterial to our findings.

We obtain stock prices, returns, shares outstanding, and volume from the CRSP database. Our sample includes NYSE-listed stocks over the period January 16, 1995, to December 15, 2004. Because the short-interest data provide the short position in the middle of a calendar month, in this study, month t denotes the dates from the first business day after the 15^{th} of calendar month $t-1$ to the 15^{th} of calendar month t, or to the last business day before the 15^{th} if the 15^{th} is not a business day. For example, the first month in our sample is the period between January 16, 1995, to February 15, 1995, and we shall refer to it as February 1995. The monthly return of a stock is constructed from its CRSP daily returns as the buy-and-hold return in month t. Similarly, we calculate the monthly risk-free rate and the Fama and French (1993) three factors from their daily values, which are obtained from Ken French's website[2]. Turnover in month t is the average daily turnover (daily trading volume divided by shares outstanding) in month t. For consistency with the sample period of the options dataset, and because we use returns of the prior year for momentum strategies, our stock sample begins in February 1995. Each month we retain only stocks with at least 15 valid daily returns. We also omit stocks with a beginning-of-the-month price of less than $5. Furthermore, the first and last partial months of each stock are deleted. We sort the stocks in the resulting NYSE universe into three sets of portfolios based on their cumulative return in the prior year, standard deviation, and turnover and short interest, respectively. Details of the

[2]We thank Ken French for making the data available on his website.

portfolio construction are described in Section 3.

Because our main analysis also considers the transaction costs in the stock market, we utilize the stock transaction database from TAQ. Following Chordia, Roll, and Subrahmanyam (2001, 2002), we use only BBO (best bid or offer)-eligible primary market (NYSE) quotes. Trades that are either out of sequence, recorded before the opening or after the closing time, or have special settlement conditions are discarded. Negative bid-ask spreads and transaction prices are also eliminated from the dataset. To avoid after hours liquidity effects (see, e.g., Barclay and Hendershott, 2004), the opening trade is ignored. We measure the transaction cost of a stock in a given day as half of the daily quoted percentage spread. The quoted percentage spread is measured for each observation as the ratio of the quoted bid-ask spread and the bid-ask midpoint. Daily estimates are obtained as simple averages throughout the day. The Appendix explains our matching methodology between CRSP and TAQ.

Because the trading strategies we examine involve buying and selling options at the end of each month, we extract end-of-month data from the options database. We merge our CRSP stock dataset and option dataset by matching securities' CUSIPs. (See appendix for details on the matching methodology.) We delete options with ask quotes lower than bid quotes. We also require options to have a positive bid quote at the beginning of each month. The resulting options dataset has $1,948,526$ monthly call option observations and $1,960,723$ monthly put observations over the period 1996-2004.

3 Identification of Overpriced Stocks

The first step of the analysis is to identify stocks that are overpriced relative to a benchmark asset-pricing model. We refer to stocks as overpriced if they earn lower returns than implied by the Fama and French (1993) three-factor model. We consider three different asset-pricing anomalies documented in the literature: the portfolio sets of momentum, volatility, and turnover/short interest. Mathematically, an overpriced stock is a stock in a portfolio p that earns negative and significant risk-adjusted returns, α_p (alpha), in the regression

$$r_{p,t} = \alpha_p + \beta_p(r_{m,t} - r_{f,t}) + \beta_{SMB,p}SMB_t + \beta_{HML,p}HML_t + \varepsilon_{p,t} \quad (1)$$

where $r_{m,t} - r_{f,t}$, SMB_t, HML_t are the three Fama-French factors, $r_{p,t}$ is the excess return of the portfolio p in month t, and $\varepsilon_{p,t}$ is the error term.

We analyze the strategy of short-selling past momentum losers, which are conjectured to be overpriced. The momentum anomaly, as documented in Jegadeesh and Titman (1993), refers to the finding that past winners outperform past losers over intermediate (up to one year) time horizons. Thus, a momentum strategy involving buying past winners and selling past losers will generate abnormal returns. Other studies, such as Jegadeesh and Titman (2001) and Grinblatt and Moskowitz (2004), have further documented that the profits of momentum strategies stem primarily from the short position of past losers rather than from the long positions of past winners, making shorting past losers a potentially attractive investment strategy for our study.

The alphas displayed in Panel A of Table 3 confirm that momentum losers are overpriced in our sample period. Panel A of Table 3 displays the alphas of ten equally weighted momentum portfolios constructed using NYSE-listed stocks. To construct momentum portfolios, we sort all NYSE-listed stocks into ten portfolios at the beginning of each month t, based on their cumulative returns during month $t-12$ through month $t-2$. Note that the alphas of the two lowest decile portfolios are significantly smaller than zero at the usual statistical significance level.

The second strategy analyzed is that of shorting stocks with high volatility. Our conjecture is based on the findings documented by Ang, Hodrick, Xing, and Zhang (2005) which shows that stocks with high idiosyncratic volatility earn negative abnormal expected returns. The alphas displayed in Panel B of Table 3 confirm that stocks with high volatility are overpriced in our sample. Panel B of Table 3 displays the alphas of ten equally weighted volatility portfolios constructed using NYSE-listed stocks during the sample period. To construct volatility portfolios we sort the firms in our sample at the beginning of each month t based on the standard deviation of their daily returns in month $t-1$. We require that there be at least 15 valid return observations in month $t-1$ for the stock to be included in month t. Note that the portfolio of stocks with the highest volatility in Panel B of Table 3 earns a negative and significant alpha.

The third set of overpriced stocks is composed of stocks with high turnover and high short interest. The model presented in Miller (1977) predicts that under heterogeneous beliefs, short-sale constrained stocks are overpriced. In addition, Boehme, Danielson, and Sorescu (2005) document that stocks in which investors have dispersed beliefs and which are short-sale constrained have low abnormal returns. Thus, to identify our third set of overpriced stocks, we conduct a two-way sort on a proxy of dispersion in beliefs and a proxy of short-sale constraints. We use turnover to proxy for the degree of dispersion in beliefs since this measure can be constructed for all firms with daily volume data. Our choice of turnover as a measure of dispersion is also motivated by theoretical works, such as Harris and Raviv (1993). We use short interest as a proxy for short-sale constraints following the common practice in the literature (see, e.g., Figlewski, 1981, and Figlewski and Webb, 1993).

The alphas displayed in Panel C of Table 3 confirm that stocks in our sample with high turnover and high short interest are overpriced. Panel C of Table 3 displays the alphas of nine equally weighted turnover/short interest portfolios constructed with NYSE stocks during the sample period. To form these portfolios, we first sort stocks into three groups based on the daily average turnover in month $t-1$. Within each of the resulting groups, we sort stocks into three groups based on the short interest at the end of month $t-1$. We require that stocks have at least 15 valid volume observations in month $t-1$. Note that the portfolio of stocks with the highest turnover and highest short interest in Panel C of Table 3 earns a negative and significant alpha.

Table 3 also reports the short interest for all of the portfolios considered here. There are a few notable findings. First, the short-interest level is fairly low overall. The median short interest is generally around 1% with the exception of the high-turnover and high-short-interest portfolio whose median short-interest level is 6.4%. The latter is not surprising because by construction, this portfolio includes stocks with the highest short interest. Second, there is a U-shape relation between momentum and the level of short interest, i.e., both losers and winners have higher short interest than the rest of the momentum portfolios. This U-shaped pattern suggests perhaps that some investors bet that past losers will underperform, while in the case of winners, there are contrarian investors who believe that the winning trend will reverse in the future. Last, for volatility portfolios, the short-interest level increases as stocks become more volatile, suggesting that investors believe that stocks with high volatility will generate lower future returns.

4 The Short-Sale Strategies and Their Returns

Three different ways to build short positions are analyzed: (1) the uncovered-short strategy, which refers to the standard short position in a stock without using options; (2) the covered-short strategy, which involves a long position in a call option and a short position in the underlying stock; and (3) the long-put strategy. A covered-short position has bounded losses insofar as losses in the short position are compensated by gains in the call option. It also implies that in a liquidity event, the short-seller can exercise the call option and return the stock to the lender. The long-put position also has bounded losses because the most a short-seller can lose using a put is its premium.

4.1 Rebate Rate, Margin-Account Rate, and Capital Allocation

This section presents the assumptions maintained for calculating the return series of the short-selling strategies with respect to rebate rate (the difference between the market interest rate and the loan fee), margin-account rate, and capital allocation.

We assume that the rebate and the margin-account rates are equal to the risk-free rate. The rebate-rate assumption is unrealistic because it is well-known that the stock-lending fee is positive. Indeed, D'Avolio (2002) reports that 91 percent of the stocks in his sample have a value-weighted average loan fee of 17 basis points per year. Moreover, our assumed rebate rate is unique across firms each month, ignoring the cross-sectional variation in rebate rates. It is important however to note that this assumption is immaterial to our analyses because stock loan fees are generally very low (see, e.g., D'Avolio, 2002). Moreover, it has been well established in the literature that even after accounting for the loan fees in stock lending, strategies such as short-selling momentum losers earn positive abnormal returns (see Geczy, Musto, and Reed, 2002).

The Appendix shows that under our assumptions about margin-account and rebate rates, the excess return of an uncovered-short position in stock i, $r_{i,t}^{US}$, is given by

$$r_{i,t}^{US} = -\frac{S_{i,t-1}}{\pi_{i,t-1}} r_{i,t} \tag{2}$$

where $S_{i,t-1}$ is the price of stock i at the beginning of month t, $r_{i,t}$ is the excess return of holding stock i during month t, and $\pi_{i,t-1}$ is the amount of capital allocated for the short position on stock i. We set the amount of capital allocated to the uncovered-short strategy equal to the price of one share of stock i, i.e. $\pi_{i,t-1} = S_{i,t-1}$, for each stock sold short in the portfolio, arriving at $r_{i,t}^{US} = -r_{i,t}$.

This assumed capital allocation has a number of advantages. First, under this assumption and without transaction costs, the alphas for the uncovered-short-selling positions are equal to the negative of the alphas displayed in Table 3. Second, the amount of allocated capital is large compared with the minimum margin-account requirements, and hence our uncovered-short strategies experience infrequent margin calls. In fact, self-regulatory organizations such as the NYSE usually require the short seller to post at least 50% of the market value of a short position as margin and maintain at least 30% of the market value of the short position in the margin account.

The excess return of the covered-short position also depends on our previously described assumptions on the margin-account and rebate rates. Under those assumptions, the Appendix shows that the excess return of a covered-short position in stock i, $r_{i,t}^{CS}$, can be described by

$$r_{i,t}^{CS} = -\frac{S_{i,t-1}}{\pi_{i,t-1}} r_{i,t} + \frac{C_{i,t-1}}{\pi_{i,t-1}} r_{C_i,t} \tag{3}$$

where $C_{i,t-1}$ is the price of the call option on stock i at the beginning of month t, and $r_{C_i,t}$ is the excess return of the call option during month t. Under some non-restrictive assumptions described in the Appendix, the expected excess return of a call option can be approximated by:

$$E_{t-1}[r_{c_i,t}] \approx \Delta_{C_i,t-1} \frac{S_{i,t-1}}{C_{i,t-1}} E_{t-1}[r_{i,t}] \tag{4}$$

where $\Delta_{C_i,t-1}$ is the delta of the call on stock i at the beginning of time t. Substituting this approximation in Equation (3), we arrive at:

$$E_{t-1}[r_{i,t}^{CS}] \approx -(1 - \Delta_{C_i,t-1}) \frac{S_{i,t-1}}{\pi_{i,t-1}} E_{t-1}[r_{i,t}] \tag{5}$$

Equation (5) implies a natural choice for the capital $\pi_{i,t-1}$, which is $(1 - \Delta_{C_i,t-1})S_{i,t-1}$ for each stock in the portfolio, arriving at $E_{t-1}[r_{i,t}^{CS}] \approx -E_{t-1}[r_{i,t}]$. Analogously to the uncovered-short strategy, this capital allocation has several advantages: Without transaction costs, the alphas for the covered-short-selling positions are equal to those of the uncovered-short strategy. Moreover, since we focus on deep-out-of-the-money call options in the covered-short strategy, the delta values ($\Delta_{C_i,t-1}$) are small and our uncovered-short strategies experience infrequent margin calls.

The excess return of the long-put position is:

$$r_{i,t}^{LP} = \frac{P_{i,t-1}}{\pi_{i,t-1}} r_{P_i,t} \tag{6}$$

where $P_{i,t-1}$ is the price of the put option on stock i at the beginning of month t, and $r_{P_i,t}$ is the excess return of the put option during month t. The expected excess return of a put option can be approximated by an equation similar to Equation (4). As a result, the excess return of a long position in a put is:

$$E_{t-1}[r_{i,t}^{LP}] \approx \Delta_{P_i,t-1} \frac{S_{i,t-1}}{\pi_{i,t-1}} E_{t-1}[r_{i,t}] \tag{7}$$

Equation (7) implies an intuitive choice for the capital $\pi_{i,t-1}$, which is $-\Delta_{P_i,t-1}S_{i,t-1}$ for each stock in the portfolio, arriving at $E_{t-1}[r_{i,t}^{LP}] = -E_{t-1}[r_{i,t}]$. Analogously to the covered-short strategies, this capital allocation has an advantage in that the alphas for the long-put positions are equal to those of the uncovered-short strategies. Unlike the uncovered and covered-short strategies, a long-put position does not involve a margin account. If the put price is lower than $-\Delta_{P_i,t-1}S_{i,t-1}$, then we assume that the investor deposits the cash amount equal to the difference between the put price and the capital $\pi_{i,t-1}$ into an account that earns the risk-free rate. If the put price is higher than $\pi_{i,t-1}$, then the investor borrows the additional amount at the risk-free rate to buy the put.

Note that we choose the capital in all three strategies to equalize the Fama and French alphas of all the short-selling strategies. Equations (2), (5), and (7) clearly imply that without transaction costs, our choice of capital results in similar alphas for the three strategies. The estimated alphas are different, however, because of the difference in transaction costs in the stock and option markets.[3]

Naturally, there are many different ways to measure the transaction costs of options. For example, transaction costs can be measured by the absolute bid-ask spread or by the relative bid-ask spread. Our choice of capital, however, implies that the relative bid-ask spread, i.e. the bid-ask spread of an option divided by the price of the underlying stock, is the appropriate measure of the transaction costs in our applications because option returns in Equations (3) and (6) are multiplied by the option prices and divided by the stock-price dependent capital of the strategy.

4.2 Margin Calls

Recall that to borrow a stock, a short seller has to place cash as collateral. The amount of cash collateral required by the stock lender is 102% for domestic stocks (see Duffie, Gârleanu, and Pedersen, 2002). If the stock price rises, the short seller must give additional collateral to the security lender such that the cash collateral remains equal to 102% of the price of the stock sold short. In addition, the short seller is required to maintain at least 30% of the stock's value in the margin account.

As a result of the collateral requirement and our assumption with respect to the initial capital investment, the initial amount in the margin account of the uncovered-short strategy is equal to 98% of the initial stock price $S_{i,t-1}$. Recall that we assume that the initial capital in the uncovered-

[3] Equations (2), (5), and (7) are based on approximations for the expected returns of calls and puts. As a result, the estimated alphas may also differ due to approximation errors.

short strategy is equal to the price of one share of stock i for each stock sold short in the portfolio. When the uncovered-short position is initiated, the short seller sells the loaned shares at the market price $S_{i,t-1}$ and deposits 102% of $S_{i,t-1}$ as collateral in the stock-lending agreement. The net cash flow in the margin account upon the initiation of the short selling position is therefore 98% of $S_{i,t-1}$ for each stock in the uncovered-short portfolio. We assume that this net cash flow is deposited in the margin account.

We assume that a margin account is established separately for each stock sold short rather than there being a single margin account for the entire portfolio. A single margin account for the entire portfolio would experience less frequent margin calls than multiple individual-stocks margin accounts. Nevertheless, the use of a margin account for each individual stock is consistent with the nature of the events that we analyze because liquidity events in short selling are naturally idiosyncratic. Moreover, the use of a single margin account for the entire portfolio would not affect the estimated costs of insurance against liquidity events because, as discussed in Section 5.2, the frequency of margin calls that we observe on single-stock margin accounts is quite low.

The margin account is marked-to-market at the end of each trading day. We assume that when the stock price increases, cash is moved from the margin account to the cash collateral account. As a result, if the stock price increases and exceeds a certain value, the funds in the two accounts will not suffice to satisfy the margin requirements. The Appendix shows that, mathematically, this happens at the first time τ ($\tau > t-1$) for which the following inequality holds

$$S_{i,\tau} \geq \frac{2S_{i,t-1}}{1.32} \tag{8}$$

Equation (8) implies a margin call when a stock in the uncovered-short portfolio has a cumulative return larger than or equal to 51.52% from the time that the short position is established. When calculating the returns of the uncovered-short strategy, we assume that when a margin call happens, the short position on stock i is closed, and the loss is carried through until the end of the month at the risk-free rate.

For the covered-short strategy, the initial capital is equal to the price of one share of stock i multiplied by one minus the delta of the call option used for hedging, i.e. $\pi_{i,t-1} = (1-\Delta_{C_i,t-1})S_{i,t-1}$ for each stock sold short in the portfolio. When the covered-short position is initiated, the short seller sells the loaned shares at the market price $S_{i,t-1}$ and deposits 102% of $S_{i,t-1}$ as collateral in the stock-lending agreement. In addition, the short seller uses the remaining capital to buy a call option on stock i. The net cash flow at the initiation of the covered-short position is therefore $S_{i,t-1}(1 - \Delta_{C_i,t-1} - 2\%) - C_{i,t-1}$. We assume that this net cash flow is deposited into the margin account. Consequently, as shown in the Appendix, a margin call occurs in the covered-short position at the first time τ ($\tau > t-1$) for which the following inequality holds

$$S_{i,\tau} \geq \frac{S_{i,t-1}(2 - \Delta_{C_i,t-1}) - C_{i,t-1}}{1.32}. \tag{9}$$

In the calculation of the returns of the covered-short strategy, we assume that when a margin call occurs, the call option used to insure against liquidity events is exercised and the short-position is closed. The loss is carried through until the end of the month at the risk-free rate Instead of exercising the call option, a short seller could sell the call option in the market and buy the stock to close out the short position. However, as a margin call may be generated by a liquidity event, it is possible that the liquidity of the stock at that time might be abnormally low. We therefore choose to exercise the call option instead of selling it while computing the returns of a covered-short position.

4.3 Option-Selection Criteria

To accomplish a meaningful comparison of the different investment strategies, we require these strategies to have similar risk-return profiles. Although options may be used to produce a wide range of strategies, we choose options that maintain the main objective of the short-selling strategy while simultaneously provide some protection against liquidity events. Thus, both the covered-short strategy and the long-put strategy are designed to resemble an uncovered-short position. To achieve this resemblance, we impose the following restrictions on the delta and time-to-maturity of the calls and puts used for the analysis.

First, the options are required to have a time-to-maturity of between one and six months. The minimum time-to-maturity of one month stems from the need to calculate monthly returns for all the strategies we analyze. Consistent with previous studies (Battalio and Schultz, 2005, and Bollen and Whaley, 2004), we limit our sample to options with time-to-maturity of no longer than six months.

Second, the options are chosen to ensure that the delta of the strategy remains between -0.7 and -1.0. The delta is used as a criterion, because it summarizes the sensitivity of the investment strategy to the change in the underlying stock price. The idea is that a short position has a delta of -1.0; that is, the short position loses one dollar for each dollar of increase in the stock price. As a result, to resemble a short position, the delta of the option strategies should be close to -1.0. This implies that we need to pick calls with small delta values in the covered-short strategies. Consequently, in the covered-short strategy, we focus on buying deep-out-of-the-money call options with delta between 0 and 0.3. In this way, the delta of the covered-short position will remain between -0.7 and -1.0. Similarly, we choose put options with delta between -0.7 and -1.0 for the long-put strategy.

Note that setting the delta of the strategy between -0.7 and -1.0 is arbitrary. In theory, we could set the delta of the strategy at any level. The problem is that not all of the deltas for options are available in the market. We assume that setting the delta between -0.7 and -1.0 is a reasonable compromise between option availability and the requirement of having options strategies resembling an uncovered-short-sale position. A sensitivity analysis (omitted for brevity) shows that the results throughout the paper are fairly robust to the choice of delta values.

Finally, in addition to restrictions on the deltas and times-to-maturity, we require the call options in the covered-short strategy to be in-the-money in case of a margin call. This restriction is important to ensure that the call options chosen for the covered-short strategy are in-the-money when there are liquidity events in the form of margin calls. To implement this restriction, we require that the call options have strike prices smaller than that on the right hand side of Equation (9).

Since we impose the restrictions above on the options of the strategies, we need to restrict our sample to stocks with options satisfying our requirements. Each portfolio constructed in Section 3 is therefore broken down into two further groups based on whether they have at least one call or one put option satisfying the above requirements. Table 4 analyzes the availability of overpriced stocks in these groups. In general, the risk-adjusted return patterns and short-interest ratios reported in Table 3 hold for the subgroup of NYSE-listed firms with available calls and puts.

Panel A of Table 4 presents the momentum portfolios constructed using stocks with options satisfying our requirements. Note that roughly 35% of the stocks in each momentum portfolio have deep-out-of-the-money call options without much variation among momentum portfolios. In addition, in contrast to the results in Table 3, the returns of stocks with deep-out-of-the-money call options are significantly negative only at the lowest decile portfolio. Panel B of Table 4 presents the volatility portfolios constructed using stocks that have options. Note that stocks with low volatilities generally do not have options—only 5% of the NYSE-listed stocks with the lowest volatility have deep-out-of-the-money calls. In addition, stocks with options and with high volatility earn negative and significant risk-adjusted returns. Panel C of Table 4 presents the turnover/SI strategies, and shows that the availability of options increases with turnover. One possible explanation for the relation between turnover and options availability is that both are proxies for liquidity, or heterogeneity of beliefs (see, e.g., Buraschi and Jiltsov, 2005). Also, the returns of stocks with options are significantly negative in the portfolio with the highest turnover and the highest short interest. Table 4 also shows that the availability of deep-in-the-money put options is similar to that of the deep-out-of-the-money call options. The returns of the portfolios with available deep-in-the-money put options are slightly lower than those with deep-out-of-the-money call options.

4.4 Portfolio Rebalancing

We assume that investors incur transaction costs only upon portfolio rebalance. If a stock remains in a portfolio from one month to the next, we assume that no transaction has occurred and thus no transaction cost has been included. If a stock enters a portfolio in month t, we subtract the transaction cost of the stock calculated at the beginning of the month from the excess return of shorting the stock in month t. If a stock exits a portfolio at the end of month t, we subtract the transaction cost of the stock calculated at the end of month t. If there is a margin call in the uncovered-short strategy, the short position is closed by selling the stock in the stock market. The transaction cost of the stock at the time of the margin call is thus subtracted from the month-to-date excess return of shorting the stock. In the covered-short strategy, the call option is exercised and the short-seller returns the stock to the stock lender. In this case, no transaction cost in the stock market is incurred.

The Ivy DB provides end-of-the-day options quotes. We assume that options are purchased at the prevailing offer price and sold at the prevailing bid price. When an option enters a portfolio in month t, we purchase the option satisfying the selection criteria with the smallest delta available. If the stock remains in the portfolio in the following month, and the option still satisfies the delta and the time-to-maturity requirements, we keep the option position for the next month, and the return of the option is calculated using the mid-quote prices rather than the bid price (for selling) and ask price (for buying).

5 The Abnormal Returns of Short-Selling Strategies

In this section we examine the costs of hedging against liquidity events in short selling. This is done by comparing the alpha of the uncovered-short strategy to that of the covered-short strategy and that of the long-put strategy.

5.1 Profitability of Uncovered-Short Strategy Versus Covered-Short Strategy

Panel A of Table 5 shows that short-selling the Losers portfolio is profitable even after considering the transaction costs in the stock market. The Fama and French (1993) alpha of the uncovered-short strategy of losers is 1.06% per month with a t-statistic of 2.51. Panel A of the table also reports that the turnover rates of stocks in the overpriced momentum portfolio are on average 2.53 months. This relatively high turnover rate suggests that our choice of maximum options' time-to-maturity equal to six months is reasonable. Notice, an investor implementing these strategies would try to minimize the cost of trading options by choosing options that would remain in the portfolio for a similar length of time as would the stock. Our choice of maximum time-to-maturity therefore does not generate excessive transactions in the options market, since the maximum time-to-maturity is larger than the average stock turnover in the portfolio.

Panel B of Table 5 shows the Fama and French (1993) alphas of the covered-short strategy. The first striking result in Panel B is that the positive and significant alpha of uncovered-short-selling stocks in the overpriced momentum portfolio turns negative, -0.04%, when a covered-short-selling strategy is implemented. The cost of the insurance against liquidity events in short-selling is the difference between the alphas of the uncovered-short and covered-short strategies. These differences are all highly significant, indicating that the cost of insurance is statistically different from zero. In addition, the cost of insuring overpriced stocks is 37 basis points higher than that of non-overpriced stocks. Panel B of Table 5 also reports the characteristics of the options used for the covered-short positions. In general, the option characteristics are similar across non-overpriced and overpriced stocks, except for relative spread, which is larger for overpriced stocks.

The results of short-selling high volatility stocks are shown in Table 6. They are consistent with those of the momentum strategies. The Fama and French (1993) alpha of short-selling stocks in Portfolio High is 0.71% with a t-statistic of 2.15, while the covered-short strategy earns -0.79% with a t-statistic of -2.16. Notice, the average time that a stock remains in Portfolio High is

1.44 months, which is shorter than the average time that the overpriced momentum stocks remain overpriced. The difference between the cost of insuring overpriced stocks and non-overpriced stocks is 54 basis points per month. Overpriced stocks are insured with options with larger moneyness, shorter time-to-maturity, and higher relative spreads.

Similarly, turnover/short-interest portfolios are analyzed in Table 7. The results are slightly different from those reported for the momentum and volatility portfolios. The alpha of the high-turnover and high-short interest portfolio is 0.60%, which is slightly smaller than the alphas for uncovered-short-selling overpriced momentum and high volatility stocks. The turnover rates of stocks in the overpriced turnover/short-interest portfolios are on average close to three months. Unlike in the cases of momentum and volatility portfolios, it is not more expensive to insure the liquidity events in short selling overpriced stocks than to insure non-overpriced stocks. In general, the options used in the insurance have similar characteristics across all portfolios except time-to-maturity. Calls on the overpriced stocks have shorter time-to-maturity than those on non-overpriced stocks.

5.2 Frequency of Margin Calls

We analyze the frequency of margin calls in the uncovered-short and covered-short strategies according to our assumptions in Section 4.2. Table 8 shows the frequency of experiencing margin calls is generally low, the highest frequency being 3.39%. The low frequency of margin calls is directly related to our assumption of a relatively high initial capital investment. Nonetheless, it is also consistent with the above-mentioned endogenous nature of liquidity events in short selling. Notably, in contrast to the low expected returns of overpriced stocks, these stocks experience more margin calls than non-overpriced stocks. This finding is consistent with Irvine (2005) that shows that stocks with higher short interest in a particular month also have a higher return skewness the next month. These results confirm the notion that margin calls are a possible form of liquidity events in short selling.

5.3 Robustness to Call Option Moneyness

So far, we have utilized deep-out-of-the-money call options to cover our short positions. Our findings indicate that such strategies are unprofitable. Nevertheless, the options literature suggests that deep-out-of-the-money options may be more expensive to trade than at-the-money options (Batallio and Schultz, 2005, and Bollen and Whaley, 2004). We therefore analyze the possibility of using at-the-money call options to hedge against the liquidity events in short selling. Two comments are noteworthy regarding the use of at-the-money call options: First, our assumption about the initial capital allocation would result in lower capital allocation in the initiation of the short position with at-the-money options. Consequently, we expect to experience a higher frequency of margin calls if at-the-money calls are used to cover the short-selling positions. Second, the profitability of the strategies depends on the bid-ask spread of the option relative to the stock price rather than the bid-ask spread relative to the option price. It is well known that deep-out-of-the-money call options may have higher spreads relative to their prices than at-the-money call options, because the former prices are usually lower than the latter prices (see, e.g., Aït-Sahalia and Duarte, 2003). The same relation may not hold for the absolute spreads. To investigate this last point, we compare the absolute spreads of deep-out-of-the-money and at-the-money call options in Table 9. The results indicate that on average, the absolute spreads of deep-out-of-the-money call options are no larger than those of at-the-money call options. We therefore conclude that using deep-out-of-the-money call options to cover short-selling strategies does not induce higher transaction costs than does using at-the-money call options.

5.4 Profitability of Uncovered-Short Strategy Versus Long-Put Strategy

Last, we compare the performance of long-put strategy with those of uncovered-short and covered-short strategies. The results for momentum, volatility, and turnover/SI portfolio sets are presented in Tables 10, 11, and 12 respectively.

Overall, the results are very similar to those reported in the previous section insofar as the long-put strategy proves unprofitable. Compare the results with those of covered-short strategies, Panels B in these three tables indicate that the cost of insurance against liquidity events in short selling is higher when puts are used. This difference can stem from either puts having higher bid-ask spreads than the calls used for the covered-short strategy, or puts having different characteristics than those calls (time-to-maturity and strike price). To pin down the reason for this difference, Panels C present the results of the long-put strategy, where instead of choosing the put options with the smallest delta between -0.7 and -1, we choose the put options with exactly the same strike and time-to-maturity as the calls used in the covered-short strategy. In this case, we require stocks to have both deep-out-of-the-money calls and deep-in-the-money puts. This causes increased turnover rates of stocks in a given portfolio, thereby reducing the profits of short-selling stocks (not tabulated), below those reported in Panels A of Tables 5, 6 and 7. Our results show that when we use puts with the same characteristics as the call options in the covered-short strategy, the costs of insurances are still much higher than those when calls are used. We therefore conclude that the increase in insurance costs from calls to puts is caused by higher bid-ask spreads of puts used for our strategies. It is possible that the absolute bid-ask spreads of these deep-in-the-money put options become higher than those of deep-out-of-the-money calls because their prices are higher than those of the calls.

6 Conclusions

This paper shows that using options to limit the maximum losses of short positions eliminates the risk-adjusted profits of several investment strategies involving short selling. Our results suggest that insurance against liquidity events such as short-squeezes and margin calls is either non-existent or too expensive. Our analysis therefore substantiates the possibility that the low-short-interest puzzle can be explained by the liquidity events in short selling. We note, however, that we are not directly measuring the cost incurred in a liquidity event in short selling, but rather the availability and the cost of insurance against liquidity events in the form of options. We therefore cannot conclude that the low observed short-interest level and the apparent profit of short-selling strategies can be fully explained by the liquidity events in short selling. Yet, to the extent that liquidity events in short selling affect stock prices and options do not provide cheap insurance against these costs, our analyses suggest that imperfections in the options market can carry over to the stock market, and may have a significant impact beyond the options market itself.

Our analysis of the liquidity events of short selling circumvents the endogeneity problem in directly estimating short-sale constraints, which are difficult to estimate because investors may perceive a high likelihood of incurring considerable costs during future liquidity events and thus avoid short selling. As a result, liquidity events in short selling become rare events. The advantage of options is that they allow short sellers to establish short-selling positions with a maximum bound on possible losses. Our analysis thus provides a market-based measure of the cost that short sellers are required to pay for insurance against potentially large positive stock price returns combined with low liquidity.

As far as we know, we explore all of the easily implementable option-based strategies to insure against liquidity events. We explore call and put options, and we also analyze options with different strikes and times-to-maturity. Nevertheless, option combinations allow for a large number of payoffs, and hence, there are many alternative strategies involving options that provide insurance against liquidity events. It is also possible that there are other strategies that do not involve options that insure against liquidity events. However, alternative insurance strategies may have complex connection with short-selling, while our strategies have a straightforward interpretation.

A Appendix

A.1 Datasets Construction

The data in the Ivy DB are organized in several files. The security file contains information on all equity and index securities known to the Ivy DB. The security ID, SECID, is the unique identifier for the security and is not recycled; it is thus the primary key for all the data contained in the Ivy DB. This file also contains the current CUSIP, ticker, and exchange for a security, while the historical record of changes to ticker, issuer and CUSIP for the security is contained in security_name file. There are 27,244 unique SECIDs in the security file. We delete the four records where two SECIDs are matched with one CUSIP.

CRSP event file contains all the historical CUSIP(NCUSIP) for a security. We merge CRSP and the Ivy DB by requiring that the current CUSIP of the security from the Ivy DB is in the historical record of CUSIP from CRSP. The resulting file contains 13,739 pairs of PERMNO-SECID, among which are 70 cases when one PERMNO is pointed to two SECIDs. After deleting these 70 records involving 70 SECIDs and 35 PERMNOs, we are left with 13,669 distinct pairs of PERMNO-SECID.

Among these 13,669 securities, 4,884 have at least one option observation in the 1996-2004 period. We delete the 94 securities that satisfy either one of the following conditions: (1) It appears in the Ivy DB earlier than in CRSP; (2) The first date of appearance in the Ivy DB is later than the last day in CRSP. If a security has options that remain in the option dataset after the last day in CRSP, all the options observations after that date are deleted. We also delete a small fraction of repetitive option observations.

Our filtered TAQ dataset has a few cases with missing observations. In these cases, we use the most recent day with available data. We merge CRSP and TAQ by symbol and date. Among the 282,819 firm-month observations in the NYSE universe from CRSP, 266,337 can be matched with the transaction data from TAQ.

A.2 Calculation of Returns on Investment Strategies

A.2.1 Returns of Uncovered-Short Strategy

At time $t-1$, the short seller receives the stock i, gives 102% of the value of the stock ($S_{i,t-1}$) as collateral, then sells the stock in the market at $S_{i,t-1}$. The short seller is required to open a margin account. Let's assume that the initial capital investment in this strategy is $\pi_{i,t-1}$, then the short seller deposits the amount of $\pi_{i,t-1} - 2\% \times S_{i,t-1}$ in the margin account. At all times between time $t-1$ and the end of the short position, the margin account is marked-to-market. If the stock price rises, the short seller must give more collateral to the security lender. If there is any dividend payment, $d_{i,u}$, between $t-1$ and time t, then the short seller also needs to pay the dividend to the stock lender. We abstract from the marked-to-market procedure by assuming that the cash flows of a short position happen at time t. At time t, the short seller closes the margin account, buys the stock at $S_{i,t}$, delivers the stock, and receives $S_{i,t-1} \times 102\% \times (1 + r^b_{i,t})$ from the stock lender where $r^b_{i,t}$ is the monthly rebate rate. The short seller also receives the proceeds in the margin account $(\pi_{i,t-1} - 2\% \times S_{i,t-1}) \times (1 + r_{mg,t})$ where $r_{mg,t}$ is the monthly rate on the margin account. Therefore, the net cash flow between time $t-1$ and time t is

$$\begin{aligned} NetCF^{US}_{i,t} &= -S_{i,t} - d_{i,u} + S_{i,t-1} \times 102\% \times \left(1 + r^b_{i,t}\right) \\ &\quad + \left(\pi_{i,t-1} - 2\% \times S_{i,t-1}\right)\left(1 + r_{mg,t}\right) - \pi_{i,t-1} \\ &= \left(-S_{i,t} - d_{i,u} + S_{i,t-1}\right) + S_{i,t-1} \times 102\% \times r^b_{i,t} + \left(\pi_{i,t-1} - 2\% \times S_{i,t-1}\right)\left(r_{mg,t}\right) \end{aligned} \tag{10}$$

Then the excess return from time $t-1$ to time t is

$$r^{US}_{i,t} = \left(-\frac{S_{i,t-1}}{\pi_{i,t-1}}\right) r_{i,t} + \frac{S_{i,t-1} \times 102\%}{\pi_{i,t-1}} \left(r^b_{i,t} - R_{f,t}\right) + \frac{\pi_{i,t-1} - 2\% \times S_{i,t-1}}{\pi_{i,t-1}} \left(r_{mg,t} - R_{f,t}\right) \tag{11}$$

where $r_{i,t}$ is the excess return of holding the stock.

The equation above can be easily understood if we see uncovered-short selling as a portfolio of three components: first, a position in the stock generating excess return $r_{i,t}$ with a portfolio weight of $-\frac{S_{i,t-1}}{\pi_{i,t-1}}$; second, a stock-loan account earning excess return of $r^b_{i,t} - R_{f,t}$ with a weight of $\frac{S_{i,t-1} \times 102\%}{\pi_{i,t-1}}$; and third, a position in a margin account with weight equal to $\frac{\pi_{i,t-1} - 2\% \times S_{i,t-1}}{\pi_{i,t-1}}$ and an excess return of $r_{mg,t} - R_{f,t}$.

If we make the assumption that both the interest rates on the margin account and the rebate rate are equal to the short-term risk-free rate, $R_{f,t}$, then the excess return of short selling a stock, $r^{US}_{i,t}$, becomes

$$r^{US}_{i,t} = -\frac{S_{i,t-1}}{\pi_{i,t-1}} r_{i,t} \tag{12}$$

where $r_{i,t}$ is the excess return of a long position in the stock. If we further assume that initial capital is equal to $S_{i,t-1}$, then the formula above becomes

$$r^{US}_{i,t} = -r_{i,t} \tag{13}$$

A.2.2 Returns of Covered-Short Strategy

At time $t-1$, the short seller receives the stock i, gives 102% of the value of the stock ($S_{i,t-1}$) as collateral, then sells the stock in the market at $S_{i,t-1}$. The short seller also buys a call option at $C_{i,t-1}$. The short seller is also required to open a margin account. Let's assume that the initial capital investment of this strategy is $\pi_{i,t-1}$, then the short seller deposits the amount of $\pi_{i,t-1} - 2\% \times S_{i,t-1} - C_{i,t-1}$ in the margin account. At all times between time $t-1$ and the end of the short position, the margin account is marked-to-market in the same way as described in Appendix A.2.1. The net cash flow between time $t-1$ and time t is

$$\begin{aligned} NetCF_{i,t}^{CS} = & \left(-S_{i,t} - d_{i,u} + S_{i,t-1}\right) + S_{i,t-1} \times 102\% \times r_{i,t}^{b} \\ & + \left(\pi_{i,t-1} - 2\% \times S_{i,t-1}\right)\left(r_{mg,t}\right) + \left(C_{i,t} - C_{i,t-1}\right) \end{aligned} \tag{14}$$

Then the excess return from time $t-1$ to time t is

$$\begin{aligned} r_{i,t}^{CS} = & -\frac{S_{i,t-1}}{\pi_{i,t-1}} r_{i,t} + \frac{S_{i,t-1} \times 102\%}{\pi_{i,t-1}} \left(r_{i,t}^{b} - R_{f,t}\right) \\ & + \frac{\pi_{i,t-1} - 2\% \times S_{i,t-1} - C_{i,t-1}}{\pi_{i,t-1}} \left(r_{mg,t} - R_{f,t}\right) + \frac{C_{i,t-1}}{\pi_{i,t-1}} r_{C_i,t} \end{aligned} \tag{15}$$

where $r_{i,t}$ is the excess return of holding a stock, and $r_{C_i,t}$ is the excess return of holding the call option $\frac{C_{i,t} - C_{i,t-1}}{C_{i,t-1}} - R_{f,t}$.

The excess returns of the covered-short selling can be understood as the excess returns of a portfolio composed of: first, a position in the stock earning excess return $r_{i,t}$ with a portfolio weight of $-\frac{S_{i,t-1}}{\pi_{i,t-1}}$; second, a stock-loan account earning an excess return of $r_{i,t}^{b} - R_{f,t}$ with a portfolio weight of $\frac{S_{i,t-1} \times 102\%}{\pi_{i,t-1}}$; third, a position in the margin account earning excess return $r_{mg,t} - R_{f,t}$ with a portfolio weight of $\frac{\pi_{i,t-1} - 2\% \times S_{i,t-1} - C_{i,t-1}}{\pi_{i,t-1}}$; and fourth, a position in a call option earning an excess return of $r_{C_i,t}$ with a weight of $\frac{C_{i,t-1}}{\pi_{i,t-1}}$.

If the margin rate and rebate rate equal the short-term risk-free rate $R_{f,t}$, then the excess return of the covered-short position is

$$r_{i,t}^{CS} = -\frac{S_{i,t-1}}{\pi_{i,t-1}} r_{i,t} + \frac{C_{i,t-1}}{\pi_{i,t-1}} r_{C_i,t} \tag{16}$$

Under the assumption that the underlying stock return drives the excess option returns (the price of volatility and interest-rate risks are zero), the expected excess return of a call option can be approximated by the expected excess return of the stock multiplied by the elasticity of the option.

$$\begin{aligned} E_{t-1}[r_{C_i,t}] &\approx \xi_{C_i,t} E_{t-1}[r_{i,t}] \\ &= \Delta_{C_i,t-1} \frac{S_{i,t-1}}{C_{i,t-1}} E_{t-1}[r_{i,t}] \end{aligned} \tag{17}$$

where $\xi_{C_i,t}$ is the elasticity of the option, $\Delta_{C_i,t-1}$ is the delta of the option, $C_{i,t-1}$ is the option price, and $S_{i,t-1}$ is the price of stock i. The equation implies that the expected excess return of the option is determined by the expected excess return of the stock, as well as the leverage the option provides, which is the elasticity of the option. The relationship above implies that the expected excess return of the covered-short strategy can be written as

$$E_{t-1}[r_{i,t}^{CS}] \approx -\frac{S_{i,t-1}}{\pi_{i,t-1}} \left(1 - \Delta_{C_i,t-1}\right) E_{t-1}[r_{i,t}] \tag{18}$$

A.2.3 Returns of Long-Put Strategy

We again assume that the initial investment of buying a put contract is $\pi_{i,t-1}$. If the put price, $P_{i,t-1}$, is lower than $\pi_{i,t-1}$, then after buying the put option, the investor puts the remaining cash into an account paying the risk-free rate. If the put price is higher than $\pi_{i,t-1}$, then we assume that the investor borrows the difference at the risk-free interest rate. In both cases, the cash flow at time t is $P_{i,t} - (P_{i,t-1} - \pi_{i,t-1})(1 + r_{mg,t})$. Then, the return in excess of the risk-free rate is

$$r_{i,t}^{LP} = \frac{P_{i,t-1}}{\pi_{i,t-1}} r_{P_i,t} \tag{19}$$

where $r_{P_i,t}$ is the excess return of the put option. Applying an analysis analogous to the one in Equation (17), the expected excess return of the long-put strategy is approximately

$$E_{t-1}(r_{i,t}^{LP}) \approx \frac{S_{i,t-1}}{\pi_{i,t-1}} \Delta_{P_i,t-1} E_{t-1}[r_{i,t}] \tag{20}$$

A.3 Margin Calls

A.3.1 Uncovered-Short Strategy

At time $t-1$, the short seller receives the stock, gives 102% of the value of the stock ($S_{i,t-1}$) as collateral, and sells the stock in the market at $S_{i,t-1}$. The short seller is required to deposit 50% of the stock value in a margin account and maintain at least 30% of the stock value in this account. Let's assume that the initial capital investment of this strategy is $\pi_{i,t-1}$, then the short seller deposits the amount of $\pi_{i,t-1} - 2\% \times S_{i,t-1}$ in the margin account. At all times between the initiation and the end of the short position, the margin account is marked-to-market. If the stock price rises, the short seller must give more collateral to the security lender.

We assume that the short-seller can move the money from the margin account to the cash collateral account. If the stock price exceeds a certain point, the money in the two accounts will not be sufficient to satisfy the requirements. This happens at time τ when the following inequality no longer holds

$$\pi_{i,t-1} - 2\% \times S_{i,t-1} + 102\% \times S_{i,t-1} \geq 30\% \times S_{i,\tau} + 102\% \times S_{i,\tau} = 132\% \times S_{i,\tau} \tag{21}$$

where 30% is the requirement of the margin account.

If $\pi_{i,t-1}$ is equal to the initial stock price $S_{i,t-1}$, then when stock price reaches $\frac{2}{1.32}S_{i,t-1}$, the short seller will receive a margin call. This happens at the first time τ ($\tau > t-1$) when the stock's cumulative return since establishing the short position becomes larger than or equal to 51.52%.

A.3.2 Covered-Short Strategy

At time $t-1$, the short seller receives the stock, gives 102% of the value of the stock ($S_{i,t-1}$) as collateral, and sells the stock in the market at $S_{i,t-1}$. The short seller also buys a call option at $C_{i,t-1}$. In addition, the short seller is required to open a margin account which requires at least 30% of the stock value. Let's assume that the initial capital investment of this strategy is $\pi_{i,t-1}$, then the short seller deposits the amount of $\pi_{i,t-1} - 2\% \times S_{i,t-1} - C_{i,t-1}$ in the margin account. At all times between the initiation and the end of the short position, the margin account is marked-to-market. Moreover, if the stock price rises, the short seller must give more collateral to the security lender.

We assume that the short-seller can move the money from the margin account to the cash collateral account. The short seller will receive a margin call if the following inequality no longer holds at time τ

$$\pi_{i,t-1} - 2\% \times S_{i,t-1} - C_{i,t-1} + 102\% \times S_{i,t-1} \geq 132\% \times S_{i,\tau} \tag{22}$$

If the initial capital is equal to $S_{i,t-1}\left(1 - \Delta_{C_i,t-1}\right)$ then short seller gets a margin call at time τ if

$$S_{i,\tau} \geq \frac{S_{i,t-1}\left(2 - \Delta_{C_i,t-1}\right) - C_{i,t-1}}{1.32} \tag{23}$$

This implies that there is no single cut-off return that we can use to determine whether a margin call is made. It will vary with stock and month.

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Table 1

Summary Statistics

This table presents the summary statistics for options on NYSE stocks from January 1996 to December 2004. Only options with open interest greater than zero and non-missing delta value are included. Moneyness is strike price divided by stock price. Delta is option's delta from the Ivy DB. Spread is the difference between ask and bid option prices. Spread/C is spread scaled by the midpoint of ask and bid call price. Spread/P is spread scaled by the midpoint of ask and bid put price. Spread/S is spread scaled by the price of the underlying stock. OI/SO denotes the option's open interest divided by the shares outstanding of the stock. Vol/SO is the option's volume divided by shares outstanding of the stock. For each year, we report the time-series average of the daily cross sectional average of option statistics for each stock including Minimal, Median, Max and Mean weighted by open interest, as well as the time-series average of the daily cross sectional average of the daily sum of Vol/SO and OI/SO of all options for each stock.

Panel A: Call Options

	Moneyness				Time-to-Maturity (days)				Delta				Spread	Spread/C (%)	Spread/S (%)	Vol/SO(%)	OI/SO(%)
Year	Mean	Min	Median	Max	Mean	Min	Median	Max	Mean	Min	Median	Max	Mean	Mean	Mean	Daily Sum	Daily Sum
1996	1.03	0.83	1.02	1.21	101	34	109	253	0.52	0.21	0.55	0.85	0.27	29.98	1.00	0.03	0.49
1997	1.03	0.81	1.02	1.21	94	27	98	248	0.53	0.19	0.55	0.86	0.29	33.00	0.98	0.02	0.48
1998	1.09	0.82	1.07	1.37	97	27	98	257	0.46	0.15	0.48	0.82	0.28	44.22	1.11	0.02	0.47
1999	1.10	0.81	1.08	1.39	98	29	99	261	0.46	0.16	0.48	0.82	0.28	45.04	1.31	0.02	0.46
2000	1.14	0.82	1.11	1.49	98	29	99	262	0.45	0.16	0.48	0.80	0.28	46.96	1.42	0.02	0.52
2001	1.14	0.79	1.10	1.55	110	26	110	304	0.43	0.13	0.47	0.84	0.25	45.65	1.20	0.03	0.67
2002	1.17	0.79	1.11	1.61	123	29	118	318	0.41	0.11	0.44	0.84	0.23	50.82	1.23	0.03	0.69
2003	1.07	0.74	1.04	1.44	126	30	127	352	0.48	0.14	0.51	0.87	0.23	44.08	1.23	0.03	0.75
2004	1.04	0.74	1.02	1.33	132	27	134	380	0.48	0.13	0.52	0.89	0.25	40.40	0.97	0.04	0.95

Panel B: Put Options

	Moneyness				Time-to-Maturity (days)				Delta				Spread	Spread/P (%)	Spread/S (%)	Vol/SO(%)	OI/SO(%)
Year	Mean	Min	Median	Max	Mean	Min	Median	Max	Mean	Min	Median	Max	Mean	Mean	Mean	Daily Sum	Daily Sum
1996	0.96	0.83	0.98	1.13	103	46	110	238	-0.38	-0.67	-0.39	-0.18	0.24	40.16	0.99	0.01	0.23
1997	0.94	0.79	0.96	1.12	92	34	93	231	-0.34	-0.66	-0.34	-0.13	0.24	55.04	0.93	0.01	0.24
1998	0.99	0.80	1.00	1.24	95	34	94	240	-0.40	-0.72	-0.40	-0.17	0.28	43.00	1.21	0.01	0.25
1999	0.98	0.79	0.99	1.25	97	34	97	247	-0.39	-0.72	-0.39	-0.17	0.27	42.57	1.41	0.01	0.24
2000	1.00	0.79	1.02	1.33	96	33	97	254	-0.41	-0.73	-0.41	-0.18	0.28	40.35	1.58	0.01	0.29
2001	0.99	0.75	1.00	1.38	111	31	109	294	-0.39	-0.77	-0.39	-0.13	0.26	40.51	1.32	0.02	0.42
2002	1.00	0.74	1.02	1.43	125	33	115	307	-0.41	-0.79	-0.41	-0.14	0.24	37.62	1.39	0.02	0.54
2003	0.93	0.69	0.97	1.32	134	32	122	343	-0.33	-0.76	-0.34	-0.10	0.22	56.06	1.27	0.02	0.61
2004	0.92	0.68	0.95	1.24	144	31	132	374	-0.32	-0.78	-0.34	-0.09	0.22	54.98	0.96	0.02	0.86

Table 2

Comparison of Data From CBOE and Ivy DB

To compare two datasets, we select the data of options on S&P500 index from both sources, the intra-daily quotes downloaded from CBOE and the daily closing quotes from the Ivy DB. Options are matched by date, root, suffix, strike price, and maturity date. Moneyness is the strike price of the option divided by the daily closing value of S&P500 index obtained from CBOE. Time-to-maturity is the number of days to the expiration date of the option. The sample period is from January 2, 2001 to December 31, 2002 with 253,908 option-date observations. We compute the intra-day average relative bid-ask spread (relative to the level of the index at the same time) from CBOE using the quotes before 3:00pm. The table reports the time-series median of the daily cross-sectional median (per moneyness and time-to-maturity group) of the ratio between the average intra-day relative spread from CBOE and the daily closing relative spread from the Ivy DB.

Time-to-maturity	Moneyness								
(days)	< 0.65	0.65-0.75	0.75-0.85	0.85-0.95	0.95-1.05	1.05-1.15	1.15-1.25	1.25-1.35	> 1.35
7-29	0.9969	0.9808	0.9170	0.9128	0.9116	0.9128	0.9138	0.9135	0.9146
30-39	1.0067	0.9177	0.9131	0.9122	0.9096	0.9131	0.9133	0.9139	0.9132
40-49	0.9970	0.9171	0.9128	0.9126	0.9117	0.9130	0.9138	0.9124	0.9108
50-59	0.9705	0.9138	0.9152	0.9140	0.9129	0.9136	0.9141	0.9141	0.9134
60-69	0.9180	0.9131	0.9133	0.9130	0.9124	0.9120	0.9123	0.9120	0.9109
70-79	0.9196	0.9131	0.9138	0.9130	0.9133	0.9129	0.9138	0.9124	0.9125
80-89	0.9140	0.9144	0.9138	0.9129	0.9138	0.9129	0.9133	0.9139	0.9141

Table 3
Identification of Overpriced Stocks

This table considers three portfolio sets: ten momentum portfolios, ten volatility portfolios, and 3x3 turnover/short interest portfolios. At the beginning of each month, the momentum portfolios are constructed by grouping the stocks into ten portfolios based on the prior year's cumulative return (excluding the last month). The volatility portfolios are formed by sorting stocks based on the standard deviation of daily returns in the previous month. To construct the nine turnover/short interest portfolios each month, stocks are first sorted into three groups based on the average daily turnover in the prior month, and then among each group, stocks are further divided into three groups based on the short interest measured at the end of the last month. Turnover and short interest (SI) are measured as the trading volume and uncovered short position, respectively, both scaled by the total number of shares outstanding. For all portfolios constructed above, we report the Fama-French three factor risk-adjusted return (alpha), the *t*-statistic of alpha, and the time-series average of the mean and median short-interest of stocks in each portfolio. The sample includes NYSE-listed stocks with stock price of no less than $5 at the portfolio formation date for the period February 1996 through December 2004.

Panel A: 10 momentum portfolios											
Momentum	Losers	2	3	4	5	6	7	8	9	Winners	Winners minus losers
Alpha	-1.45	-0.58	-0.21	-0.04	0.08	0.07	0.16	0.13	0.28	0.78	2.23
T-Statistic	-3.68	-2.21	-1.02	-0.22	0.52	0.46	1.05	0.80	1.91	3.83	4.59
Median SI	1.76	1.10	0.84	0.69	0.62	0.65	0.73	0.86	1.03	1.40	-0.36
Mean SI	3.98	2.95	2.09	1.84	1.77	1.70	2.39	2.55	5.62	3.68	-0.30
Panel B: 10 volatility portfolios											
Volatility	Low	2	3	4	5	6	7	8	9	High	High minus low
Alpha	0.14	0.11	0.07	0.03	-0.08	-0.02	-0.21	-0.06	-0.16	-0.72	-0.85
T-Statistic	0.78	0.71	0.50	0.18	-0.49	-0.09	-1.21	-0.33	-0.69	-2.92	-2.80
Median SI	0.11	0.32	0.66	0.85	1.00	1.14	1.26	1.39	1.57	1.89	1.78
Mean SI	1.14	1.37	2.05	2.30	2.99	3.49	4.40	4.39	4.51	4.97	3.84
Panel C: 3 x 3 turnover/SI portfolios											
Turnover		Low			Medium			High		High turnover	High SI
SI	Low		High	Low		High	Low		High	minus low turnover	minus low SI
Alpha	0.18	-0.09	-0.27	0.20	0.01	-0.30	0.45	-0.21	-0.82	-0.13	-0.74
T-Statistic	1.16	-0.59	-1.81	1.27	0.08	-1.68	2.50	-1.02	-3.89	-0.81	-6.65
Median SI	0.03	0.20	0.96	0.28	0.95	2.48	0.78	2.28	6.41	2.08	2.72
Mean SI	0.03	0.21	4.49	0.28	0.97	4.06	0.78	2.35	15.33	4.57	7.60

Table 4

Availability of Deep-Out-of-the-Money (OTM) Calls and Deep-In-the-Money (ITM) Puts

This table presents the availability of deep-out-of-the-money calls and deep-in-the-money puts for stocks in three portfolio sets: ten momentum portfolios, ten volatility portfolios, and 3x3 turnover/short interest portfolios. At the beginning of each month, the momentum portfolios are constructed by grouping the stocks into ten portfolios based on the prior year's cumulative return (excluding the last month). The volatility portfolios are formed by sorting stocks based on the standard deviation of daily returns in the prior month. To construct the nine turnover/short interest portfolios each month, stocks are first sorted into three groups based on the average daily turnover in the prior month, and then among each group, stocks are further divided into three groups based on the short interest measured at the end of the prior month. Turnover and short interest (SI) are measured as the trading volume and uncovered short position, respectively, both scaled by the total number of shares outstanding. For all portfolios constructed above, we further select stocks into two subsets based on whether there exists a deep-out-of-the-money call or deep-in-the-money put on the stock. Details on option selection criteria are described in Section 4. We report the percentage of NYSE stocks with deep-otm calls and deep-itm puts, the Fama-French three factor risk-adjusted return (alpha), the *t*-statistic of alpha, and the time-series average of the mean short-interest of stocks in each subset. The sample includes NYSE-listed stocks with stock price of no less than $5 at the portfolio formation date for the period February 1996 through December 2004.

Panel A: 10 momentum portfolios

		Losers	2	3	4	5	6	7	8	9	Winners	Winners minus losers
Stocks with deep-OTM calls	% of NYSE firms	40.84	40.41	36.32	31.71	29.97	30.39	32.94	35.82	39.19	39.96	-0.87
	Alpha	-1.24	-0.52	-0.25	0.17	-0.18	-0.20	-0.01	0.20	0.37	0.75	1.99
	T-Statistic	-3.01	-1.69	-0.96	0.71	-0.79	-0.91	-0.08	1.00	2.39	2.86	3.78
	Short interest	4.84	3.06	2.64	2.46	2.42	2.52	2.36	2.50	2.72	3.62	-1.22
Stocks with deep-ITM puts	% of NYSE firms	50.33	43.80	38.88	33.28	31.46	31.85	34.46	37.37	40.75	42.09	-8.24
	Alpha	-1.36	-0.61	-0.29	0.01	-0.26	-0.30	-0.04	0.03	0.31	0.57	1.93
	T-Statistic	-3.19	-1.98	-1.14	0.05	-1.18	-1.39	-0.19	0.14	1.94	2.36	3.58
	Short interest	4.96	3.12	2.65	2.47	2.41	2.55	2.36	2.51	2.69	3.62	-1.34

Panel B: 10 volatility portfolios

		Low	2	3	4	5	6	7	8	9	High	High minus low
Stocks with deep-OTM calls	% of NYSE firms	4.77	17.16	30.00	38.15	42.37	44.46	45.05	45.37	43.04	38.56	33.79
	Alpha	0.06	0.13	-0.01	0.01	0.03	0.16	-0.03	-0.07	-0.13	-0.95	-1.00
	T-Statistic	0.21	0.59	-0.04	0.07	0.15	0.80	-0.17	-0.32	-0.47	-2.91	-2.36
	Short interest	1.55	1.82	2.66	2.20	2.42	2.56	3.02	3.32	4.29	4.86	3.29
Stocks with deep-ITM puts	% of NYSE firms	5.54	18.17	31.14	39.49	43.67	46.16	47.37	48.01	47.86	48.19	42.65
	Alpha	0.03	0.04	-0.04	-0.10	-0.04	0.07	-0.19	-0.22	-0.25	-1.19	-1.25
	T-Statistic	0.15	0.19	-0.24	-0.52	-0.18	0.33	-0.90	-0.95	-0.91	-3.71	-3.07
	Short interest	1.59	1.80	2.63	2.18	2.40	2.56	3.03	3.32	4.29	5.02	3.42

Panel C: 3 x 3 turnover/SI portfolios

	turnover	Low			Medium			High			High turnover	High SI
	SI	Low		High	Low		High	Low		High	minus low turnover	minus low SI
Stocks with deep-OTM calls	% of NYSE firms	1.93	9.20	25.20	20.03	51.69	51.93	40.89	61.45	57.34	41.12	23.87
	Alpha	-0.12	-0.17	-0.11	0.26	0.04	-0.09	0.51	-0.04	-0.71	-0.05	-0.82
	T-Statistic	-0.23	-0.61	-0.55	1.00	0.21	-0.47	2.30	-0.16	-2.71	-0.25	-6.29
	Short interest	0.05	0.26	1.43	0.39	0.99	3.18	0.92	2.35	9.38	3.46	4.88
Stocks with deep-ITM puts	% of NYSE firms	2.27	10.49	27.44	21.80	54.39	55.40	43.77	65.26	63.23	44.03	26.08
	Alpha	-0.12	-0.30	-0.32	0.13	0.01	-0.22	0.41	-0.17	-0.93	-0.02	-0.86
	T-Statistic	-0.16	-1.10	-1.53	0.51	0.07	-1.08	1.86	-0.76	-3.55	-0.11	-6.09
	Short interest	0.05	0.26	1.43	0.39	0.99	3.21	0.92	2.36	9.52	3.57	4.98

Table 5

Profitability of Momentum Portfolios for Uncovered-Short and Covered-Short Strategies

This table reports the profitability of the momentum portfolios using uncovered-short and covered-short strategies. At the beginning of each month, the momentum portfolios are constructed by grouping the stocks into ten portfolios based on the prior year's cumulative return (excluding the last month). Then within each portfolio, we select stocks with deep-out-of-the-money calls with delta value between 0 and 0.3 and maturity between one and six months. Uncovered-short strategy refers to the standard short position in a stock. Covered-short strategy involves a long position in a call option and a short position in the underlying stock. In the event of a margin call, the short position is closed, the option is exercised, and losses are carried through to the end of the month at the risk free rate. In calculating the returns of both short strategies, we incorporate the transaction costs in the stock and options markets when there is portfolio rebalancing. Details on the option selection criteria and returns calculation are described in Section 4. We report the Fama-French three factor risk-adjusted return (alpha) and the t-statistic of alpha for both short strategies. Panel A also presents the average time a stock remains in each portfolio in the uncovered-short strategy. Panel B also reports the characteristics of the options used in the covered-short strategy, such as delta, time-to-maturity (days to expiration date), moneyness (K/S), spread/S (option bid-ask spread relative to stock price), as well as the average time an option remains in the same portfolio. The overpriced portfolio is the lowest decile portfolio, and the non-overpriced portfolio includes the rest. The sample includes NYSE-listed stocks with stock price of no less than $5 at the portfolio formation date for the period February 1996 through December 2004.

	Overpriced	Non-Overpriced									Overpriced minus
Portfolios	Losers	2	3	4	5	6	7	8	9	Winners	non-overpriced
Panel A: Uncovered-short											
Alpha	1.06	0.36	0.07	-0.34	0.00	0.04	-0.13	-0.33	-0.50	-0.85	1.27
T-Statistic	2.51	1.17	0.26	-1.37	0.02	0.17	-0.67	-1.68	-3.20	-3.23	3.71
Stock's average time in portfolio (months)	2.53	1.63	1.39	1.29	1.24	1.24	1.27	1.34	1.53	2.22	
Panel B: Covered-short											
Alpha of covered-short	-0.04	-0.50	-0.71	-1.14	-0.84	-0.76	-0.86	-1.03	-1.27	-1.62	0.93
T-Statistic	-0.08	-1.49	-2.62	-4.50	-3.36	-3.16	-3.88	-4.73	-7.39	-5.33	2.41
Alpha of uncovered-short minus covered-short	1.16	0.94	0.85	0.75	0.81	0.74	0.78	0.73	0.73	0.83	0.37
T-Statistic	13.53	15.68	18.04	18.91	18.61	16.49	17.49	15.86	17.42	13.14	5.08
Option's average time in portfolio (months)	1.12	1.10	1.09	1.07	1.07	1.06	1.07	1.07	1.09	1.08	
Delta	0.16	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.16	
Moneyness (K/S)	1.25	1.23	1.21	1.20	1.20	1.19	1.19	1.18	1.19	1.21	
Time-to-Maturity (days)	71	81	83	83	81	80	77	74	69	60	
Spread/S (%)	1.12	0.88	0.79	0.73	0.69	0.67	0.65	0.64	0.63	0.67	

Table 6

Profitability of Volatility Portfolios of Uncovered-Short and Covered-Short Strategies

This table reports the profitability of the volatility portfolios using uncovered-short and covered-short strategies. The volatility portfolios are formed by sorting stocks based on the standard deviation of daily returns in the prior month. Then within each portfolio, we select stocks with deep-out-of-the-money calls with delta value between 0 and 0.3 and maturity between one and six months. Uncovered-short strategy refers to the standard short position in a stock. Covered-short strategy involves a long position in a call option and a short position in the underlying stock. In the event of a margin call, the short position is closed, the option is exercised, and losses are carried through to the end of the month at the risk free rate. In calculating the returns of both short strategies, we incorporate the transaction costs in the stock and options markets when there is portfolio rebalancing. Details on the option selection criteria and returns calculation are described in Section 4. We report the Fama-French three factor risk-adjusted return (alpha) and the t-statistic of alpha for both short strategies. Panel A also presents the average time a stock remains in each portfolio in the uncovered-short strategy. Panel B also reports the characteristics of the options used in the covered-short strategy, such as delta, time-to-maturity (days to expiration date), moneyness (K/S), spread/S (option bid-ask spread relative to stock price), as well as the average time an option remains in the same portfolio. The overpriced portfolio is the highest decile portfolio, and the non-overpriced portfolio includes the rest. The sample includes NYSE-listed stocks with stock price of no less than $5 at the portfolio formation date for the period February 1996 through December 2004.

	Non-overpriced									Overpriced	Overpriced minus
Portfolios	Low	2	3	4	5	6	7	8	9	High	non-overpriced
Panel A: Uncovered-short											
Alpha	-0.18	-0.27	-0.14	-0.16	-0.20	-0.34	-0.14	-0.13	-0.11	0.71	0.90
T-Statistic	-0.67	-1.23	-0.81	-0.86	-0.93	-1.67	-0.70	-0.56	-0.40	2.15	3.28
Stock's average time in portfolio (months)	1.24	1.29	1.22	1.20	1.19	1.17	1.19	1.21	1.25	1.44	
Panel B: Covered-short											
Alpha of covered-short	-0.96	-0.90	-0.78	-0.77	-0.93	-1.15	-0.98	-1.11	-1.13	-0.79	0.21
T-Statistic	-3.13	-4.07	-4.40	-3.81	-4.20	-5.06	-4.59	-4.39	-3.69	-2.16	0.67
Alpha of uncovered-short minus covered-short	0.65	0.73	0.68	0.68	0.71	0.78	0.84	0.95	1.08	1.36	0.54
T-Statistic	10.05	11.30	17.52	18.63	19.34	18.20	19.82	18.73	17.58	18.38	8.80
Option's average time in portfolio (months)	1.08	1.08	1.06	1.06	1.05	1.04	1.04	1.04	1.04	1.02	
Delta	0.16	0.16	0.15	0.15	0.15	0.15	0.15	0.15	0.16	0.16	
Moneyness (K/S)	1.12	1.15	1.17	1.18	1.19	1.20	1.22	1.23	1.24	1.26	
Time-to-Maturity (days)	100	91	86	83	80	77	75	70	66	59	
Spread/S (%)	0.60	0.65	0.63	0.64	0.66	0.71	0.76	0.81	0.89	1.01	

Table 7

Profitabilityof Turnover/SI Portfolios on Uncovered-Short and Covered-Short Strategies

This table reports the profitability of the turnover/SI portfolios using uncovered-short and covered-short strategies. To construct the nine turnover/short interest portfolios each month, stocks are first sorted into three groups based on the average daily turnover in the prior month, and then within each group, stocks are further divided into three groups based on the short interest measured at the end of the prior month. Turnover and short interest (SI) are measured as the trading volume and uncovered short position, respectively, both scaled by the total number of shares outstanding. Then within each portfolio, we select stocks with deep-out-of-the-money calls with delta value between 0 and 0.3 and maturity between one and six months. Uncovered-short strategy refers to the standard short position in a stock. Covered-short strategy involves a long position in a call option and a short position in the underlying stock. In the event of a margin call, the short position is closed, the option is exercised, and losses are carried through to the end of the month at the risk free rate. In calculating the returns of both short strategies, we incorporate the transaction costs in the stock and options markets when there is portfolio rebalancing. Details on the option selection criteria and returns calculation are described in Section 4. We report the Fama-French three factor risk-adjusted return (alpha) and the t-statistic of alpha for both short strategies. Panel A also presents the average time a stock remains in each portfolio in the uncovered-short strategy. Panel B also reports the characteristics of the options used in the covered-short strategy, such as delta, time-to-maturity (days to expiration date), moneyness (K/S), spread/S (option bid-ask spread relative to stock price), as well as the average time an option remains in the same portfolio. The overpriced portfolio is the high turnover and high short interest portfolio, and the non-overpriced portfolio includes the rest. The sample includes NYSE-listed stocks with stock price of no less than $5 at the portfolio formation date for the period February 1996 through December 2004.

		Non-overpriced								Overpriced	Overpriced minus non-overpriced
Portfolios	Turnover	Low			Medium			High		High	
	SI	Low		Low	Low		High	Low	Medium	High	
Panel A: Uncovered-short											
Alpha		-0.07	-0.01	-0.03	-0.43	-0.14	-0.03	-0.65	-0.06	0.60	0.77
T-Statistic		-0.13	-0.02	-0.13	-1.67	-0.84	-0.14	-2.87	-0.28	2.26	4.62
Stock's average time in portfolio (months)		1.86	1.95	1.90	1.85	2.04	1.95	1.95	2.21	3.18	
Panel B: Covered-short											
Alpha of covered-short		-1.01	-0.86	-0.91	-1.50	-0.88	-0.83	-1.54	-0.81	-0.11	0.86
T-Statistic		-1.66	-2.74	-4.12	-5.02	-4.68	-3.77	-6.08	-3.23	-0.39	4.68
Alpha of uncovered-short minus covered-short		1.11	1.00	0.88	1.00	0.70	0.74	0.91	0.78	0.78	-0.03
T-Statistic		7.54	15.18	15.50	13.36	18.88	18.00	20.94	15.97	14.42	-0.65
Option's average time in portfolio (months)		1.16	1.14	1.14	1.14	1.14	1.14	1.10	1.10	1.11	
Delta		0.18	0.17	0.17	0.16	0.15	0.16	0.15	0.15	0.15	
Moneyness (K/S)		1.19	1.18	1.17	1.20	1.19	1.19	1.22	1.22	1.23	
Time-to-Maturity (days)		90	86	85	84	80	81	73	68	64	
Spread/S (%)		1.22	0.99	0.91	0.87	0.69	0.81	0.74	0.69	0.78	

Table 8
Frequency of Margin Call (%)

This table reports the frequency of margin calls in uncovered-short and covered-short strategies. Each month, we construct portfolios of uncovered-short and covered-short positions on three portfolio sets: ten momentum portfolios, ten volatility portfolios, and 3x3 turnover/short interest portfolios. At the beginning of each month, the momentum portfolios are constructed by grouping the stocks into ten portfolios based on the prior year's cumulative return (excluding the last month). The volatility portfolios are formed by sorting stocks based on the standard deviation of daily returns in the prior month. To construct the nine turnover/short interest portfolios each month, stocks are first sorted into three groups based on the average daily turnover in the prior month, and then within each group, stocks are further divided into three groups based on the short interest measured at the end of the prior month. Turnover and short interest (SI) are measured as the trading volume and uncovered short position, respectively, both scaled by the total number of shares outstanding. The table reports the average of the frequency of margin calls for each portfolio for both uncovered-short and covered-short strategies. For details on the calculations of the margin calls, see Section 4. The sample includes NYSE-listed stocks with stock price of no less than $5 at the portfolio formation date for the period February 1996 through December 2004.

Panel A: 10 momentum portfolios

Momentum	Losers	2	3	4	5	6	7	8	9	Winners
Uncovered-short	0.60	0.18	0.20	0.15	0.09	0.06	0.12	0.15	0.16	0.33
Covered-short	2.55	0.97	0.74	0.71	0.48	0.68	0.58	0.56	0.62	1.15

Panel B: 10 volatility portfolios

Volatility	Low	2	3	4	5	6	7	8	9	High
Uncovered-short	0.00	0.02	0.03	0.04	0.07	0.13	0.19	0.25	0.35	0.80
Covered-short	0.00	0.18	0.23	0.26	0.51	0.77	0.92	1.28	1.81	3.39

Panel C: 3 x 3 turnover/SI portfolios

Turnover		Low			Medium			High	
SI	Low		High	Low		High	Low		High
Uncovered-short	0.07	0.08	0.14	0.15	0.06	0.21	0.24	0.23	0.46
Covered-short	0.67	0.89	0.79	0.60	0.43	0.82	1.04	0.99	1.66

Table 9

Transaction Cost of Deep-OTM Calls and ATM Calls

This table reports the transaction costs of deep-out-of-the-money (deep-OTM) calls and at-the-money (ATM) calls on three portfolio sets: ten momentum portfolios, ten volatility portfolios, and 3x3 turnover/short interest portfolios. At the beginning of each month, the momentum portfolios are constructed by grouping the stocks into ten portfolios based on the prior year's cumulative return (excluding the last month). The volatility portfolios are formed by sorting stocks based on the standard deviation of daily return in the prior month. To construct the nine turnover/short interest portfolios each month, stocks are first sorted into three groups based on the average daily turnover in the prior month, and then within each group, stocks are further divided into three groups based on the short interest measured at the end of the prior month. Turnover and short interest (SI) are measured as the trading volume and uncovered short position, respectively, both scaled by the total number of shares outstanding. Table uses options data for stocks for which both deep-OTM and ATM calls exist. For details on the option selection criteria, see Section 4. OTM is the average spread across all deep-out-the-money calls. ATM is the average spread across all at-the-money calls. Table presents the time-series average of monthly medians. The sample includes NYSE-listed stocks with stock price of no less than $5 at the portfolio formation date for the period February 1996 through December 2004.

Panel A: 10 momentum portfolios

Momentum	Losers	2	3	4	5	6	7	8	9	Winners
OTM	0.18	0.19	0.19	0.19	0.20	0.20	0.20	0.21	0.21	0.20
ATM	0.21	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.24	0.24
OTM/ATM	0.93	0.91	0.90	0.89	0.88	0.87	0.85	0.84	0.81	0.79

Panel B: 10 volatility portfolios

Volatility	Low	2	3	4	5	6	7	8	9	High
OTM	0.22	0.21	0.21	0.21	0.20	0.20	0.19	0.19	0.19	0.18
ATM	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.22	0.22	0.22
OTM/ATM	0.92	0.93	0.89	0.88	0.86	0.85	0.84	0.85	0.84	0.85

Panel C: 3 x 3 turnover/SI portfolios

Turnover		Low			Medium			High	
SI	Low		High	Low		High	Low		High
OTM	0.22	0.20	0.22	0.20	0.20	0.21	0.19	0.19	0.18
ATM	0.24	0.23	0.24	0.22	0.22	0.24	0.23	0.23	0.23
OTM/ATM	0.93	0.92	0.95	0.92	0.86	0.92	0.83	0.81	0.82

Table 10

Profitability of Momentum Portfolios on Uncovered-Short and Long-Put Strategies

This table reports the profitability of the momentum portfolios on uncovered-short and long-put strategies. At the beginning of each month, the momentum portfolios are constructed by grouping the stocks into ten portfolios based on the prior year's cumulative return (excluding the last month). Then within each portfolio, we select stocks with deep-in-the-money puts with delta value between -1 and –0.7 and time-to-maturity between one and six months. Uncovered-short strategy refers to the standard short position in a stock. Long-put strategy involves a long position in a put option. For the uncovered-short strategy, in the event of a margin call, the short position is closed, and loss is carried through to the end of the month at the risk free rate. In calculating the returns of both short strategies, we incorporate the transaction costs in the stock and options markets when there is portfolio rebalancing. Details on the option selection criteria and returns calculation are described in Section 4. We report the Fama-French three factor risk-adjusted return (alpha) and the t-statistic of alpha for both short strategies. Panel A also presents the average time a stock remains in each portfolio. Panel B also reports the characteristics of the options used in the long-put strategy, such as delta, time-to-maturity (days to expiration date), moneyness (K/S), spread/S (option bid-ask spread relative to stock price), as well as the average time an option remains in the same portfolio. Panel C uses puts with the same strike price and time-to-maturity as the calls in the covered-short strategy. The overpriced portfolio is the lowest decile portfolio, and the non-overpriced portfolio includes the rest. The sample includes NYSE-listed stocks with stock price of no less than $5 at the portfolio formation date for the period February 1996 through December 2004.

	Overpriced	Non-overpriced								Overpriced minus
Portfolios	Losers	2	3	4	5	6	7	8	9	Winners	non-overpriced
Panel A: Uncovered-short											
Alpha	1.17	0.43	0.10	-0.18	0.08	0.13	-0.11	-0.17	-0.44	-0.66	1.28
T-Statistic	2.65	1.39	0.38	-0.72	0.34	0.61	-0.58	-0.84	-2.77	-2.74	3.53
Stock's average time in portfolio (months)	3.08	1.65	1.41	1.30	1.25	1.25	1.28	1.36	1.54	2.34	
Panel B: Long-put											
Alpha of long-put	-1.26	-1.41	-1.62	-1.88	-1.61	-1.47	-1.60	-1.61	-1.92	-2.31	0.46
T-Statistic	-2.66	-4.15	-5.81	-7.03	-6.57	-6.15	-7.15	-7.18	-10.77	-8.54	1.19
Alpha of uncovered-short minus long-put	2.51	1.98	1.81	1.65	1.63	1.56	1.54	1.52	1.47	1.57	0.87
T-Statistic	31.66	31.54	34.53	36.76	34.77	30.10	30.90	31.97	32.28	26.54	14.14
Option's average time in portfolio (months)	1.20	1.12	1.09	1.08	1.06	1.06	1.06	1.06	1.08	1.09	
Delta	-0.88	-0.89	-0.89	-0.88	-0.88	-0.88	-0.88	-0.88	-0.87	-0.87	
Moneyness (K/S)	1.54	1.35	1.30	1.27	1.25	1.24	1.23	1.23	1.24	1.27	
Time-to-Maturity (days)	82	74	72	71	69	67	65	65	63	58	
Spread/S (%)	2.85	2.01	1.78	1.61	1.52	1.47	1.40	1.39	1.39	1.54	
Panel C: Using put with the same strike and maturity as the call in the covered-short strategy											
Alpha of long-put	-1.03	-1.09	-1.40	-1.81	-1.42	-1.32	-1.52	-1.54	-1.83	-2.26	0.54
T-Statistic	-2.36	-3.37	-5.18	-6.91	-5.43	-5.55	-6.53	-6.82	-10.33	-7.91	1.52
Alpha of uncovered-short minus long-put	2.19	1.75	1.60	1.51	1.51	1.42	1.46	1.40	1.44	1.61	0.67
T-Statistic	22.24	26.53	28.59	30.79	26.91	27.14	26.52	27.90	28.89	23.58	8.30
Option's average time in portfolio (months)	1.15	1.11	1.09	1.07	1.07	1.06	1.07	1.07	1.10	1.10	
Delta	-0.84	-0.85	-0.85	-0.85	-0.85	-0.85	-0.85	-0.85	-0.85	-0.84	
Moneyness (K/S)	1.25	1.22	1.21	1.20	1.19	1.19	1.18	1.18	1.18	1.20	
Time-to-Maturity (days)	71	81	83	83	81	80	77	74	69	60	
Spread/S (%)	2.01	1.67	1.52	1.42	1.35	1.32	1.27	1.26	1.26	1.35	

Table 11
Profitability of Volatility Portfolios on Uncovered-Short and Long-Put Strategies

This table reports the profitability of the volatility portfolios on uncovered-short and long-put strategies. The volatility portfolios are formed by sorting stocks based on the standard deviation of daily returns in the prior month. Then within each portfolio, we select stocks with deep-in-the-money puts with delta value between -1 and –0.7 and time-to-maturity between one and six months. Uncovered-short strategy refers to the standard short position in a stock. Long-put strategy involves a long position in a put option. For the uncovered-short strategy, in the event of a margin call, the short position is closed, and loss is carried through to the end of the month at the risk free rate. In calculating the returns of both short strategies, we incorporate the transaction costs in the stock and options markets when there is portfolio rebalancing. Details on the option selection criteria and returns calculation are described in Section 4. We report the Fama-French three factor risk-adjusted return (alpha) and the t-statistic of alpha for both short strategies. Panel A also presents the average time a stock remains in each portfolio. Panel B also reports the characteristics of the options used in the long-put strategy, such as delta, time-to-maturity (days to expiration date), moneyness (K/S), spread/S (option bid-ask spread relative to stock price), as well as the average time an option remains in the same portfolio. Panel C uses puts with the same strike price and time-to-maturity as the calls in the covered-short strategy. The overpriced portfolio is the highest decile portfolio, and the non-overpriced portfolio includes the rest. The sample includes NYSE-listed stocks with stock price of no less than $5 at the portfolio formation date for the period February 1996 through December 2004.

	Non-overpriced									Overpriced	Overpriced minus
Portfolios	Low	2	3	4	5	6	7	8	9	High	non-overpriced
Panel A: Uncovered-short											
Alpha	-0.16	-0.18	-0.11	-0.06	-0.13	-0.26	0.00	0.00	0.00	0.91	1.01
T-Statistic	-0.68	-0.82	-0.67	-0.32	-0.64	-1.24	0.00	0.00	-0.01	2.76	3.70
Stock's average time in portfolio (months)	1.31	1.30	1.22	1.20	1.19	1.18	1.19	1.21	1.27	1.61	
Panel B: Long-put											
Alpha of long-put	-1.55	-1.45	-1.43	-1.47	-1.67	-1.91	-1.71	-1.98	-2.22	-1.96	-0.18
T-Statistic	-5.72	-6.49	-8.07	-7.42	-7.58	-8.25	-7.52	-7.72	-7.46	-5.66	-0.63
Alpha of uncovered-short minus long-put	1.30	1.40	1.35	1.45	1.52	1.63	1.74	1.96	2.23	2.65	0.95
T-Statistic	19.49	22.75	33.61	31.23	31.20	34.19	37.96	34.20	38.60	43.58	22.44
Option's average time in portfolio (months)	1.08	1.07	1.05	1.05	1.04	1.04	1.04	1.05	1.06	1.10	
Delta	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	
Moneyness (K/S)	1.14	1.18	1.20	1.22	1.23	1.25	1.28	1.32	1.38	1.52	
Time-to-Maturity (days)	69	69	67	67	66	67	67	68	70	75	
Spread/S (%)	1.23	1.33	1.30	1.37	1.43	1.54	1.67	1.85	2.13	2.66	
Panel C: Using put with the same strike and maturity as the call in the covered-short strategy											
Alpha of long-put	-1.37	-1.33	-1.26	-1.31	-1.37	-1.65	-1.62	-1.62	-1.83	-1.53	0.01
T-Statistic	-4.39	-6.03	-7.01	-6.41	-6.15	-7.69	-7.42	-6.82	-6.26	-4.49	0.04
Alpha of uncovered-short minus long-put	1.10	1.21	1.18	1.22	1.27	1.39	1.50	1.62	1.77	2.16	0.74
T-Statistic	12.91	19.73	25.33	24.11	24.13	23.39	26.60	23.64	24.23	23.80	10.78
Option's average time in portfolio (months)	1.10	1.10	1.07	1.06	1.06	1.05	1.05	1.05	1.05	1.04	
Delta	-0.82	-0.82	-0.82	-0.82	-0.82	-0.81	-0.81	-0.81	-0.81	-0.81	
Moneyness (K/S)	1.11	1.13	1.14	1.15	1.15	1.16	1.18	1.19	1.20	1.22	
Time-to-Maturity (days)	101	93	87	85	81	80	77	73	69	62	
Spread/S (%)	1.09	1.15	1.14	1.18	1.22	1.30	1.39	1.47	1.61	1.81	

Table 12

Profitability of Turnover/SI Portfolios on Uncovered-Short and Long-Put Strategies

This table reports the profitability of the turnover/SI portfolios on uncovered-short and long-put strategies. To construct the nine turnover/short interest portfolios each month, stocks are first sorted into three groups based on the average daily turnover in the prior month, and then within each group, stocks are further divided into three groups based on the short interest measured at the end of the prior month. Turnover and short interest (SI) are measured as the trading volume and uncovered short position, respectively, both scaled by the total number of shares outstanding. Then wthin each portfolio, we select stocks with deep-in-the-money puts with delta value between -1 and –0.7 and time-to-maturity between one and six months. Uncovered-short strategy refers to the standard short position in a stock. Long-put strategy involves a long position in a put option. For the uncovered-short strategy, in the event of a margin call, the short position is closed, and loss is carried through to the end of the month at the risk free rate. In calculating the returns of both short strategies, we incorporate the transaction costs in the stock and options markets when there is portfolio rebalancing. Details on the option selection criteria and returns calculation are described in Section 4. We report the Fama-French three factor risk-adjusted return (alpha) and the t-statistic of alpha for both short strategies. Panel A also presents the average time a stock remains in each portfolio. Panel B also reports the characteristics of the options used in the long-put strategy, such as delta, time-to-maturity (days to expiration date), moneyness (K/S), spread/S (option bid-ask spread relative to stock price), as well as the average time an option remains in the same portfolio. Panel C uses puts with the same strike price and time-to-maturity as the calls in the covered-short strategy. The overpriced portfolio is the high turnover and high short interest portfolio, and the non-overpriced portfolio includes the rest. The sample includes NYSE-listed stocks with stock price of no less than $5 at the portfolio formation date for the period February 1996 through December 2004.

		Non-overpriced								Overpriced	Overpriced minus non-overpriced
Portfolios	Turnover	Low			Medium			High		High	
	SI	Low		High	Low		High	Low	Medium	High	
Panel A: Uncovered-short											
Alpha		-0.22	0.13	0.17	-0.33	-0.13	0.08	-0.57	0.06	0.82	0.90
T-Statistic		-0.29	0.48	0.83	-1.28	-0.72	0.40	-2.50	0.27	3.06	5.51
Stock's average time in portfolio (months)		2.02	2.09	1.96	1.89	2.07	2.00	2.01	2.28	3.57	
Panel B: Long-put											
Alpha of long-put		-1.72	-1.54	-1.56	-2.19	-1.60	-1.62	-2.34	-1.62	-1.02	0.72
T-Statistic		-2.62	-4.98	-6.81	-7.13	-8.09	-6.97	-9.61	-6.35	-3.42	3.97
Alpha of uncovered-short minus long-put		1.98	1.94	1.73	1.83	1.47	1.65	1.78	1.71	1.86	0.19
T-Statistic		11.41	21.47	28.13	23.85	35.52	32.12	32.02	33.95	32.53	4.82
Option's average time in portfolio (months)		2.02	2.09	1.96	1.89	2.07	2.00	2.01	2.28	3.57	
Delta		-0.86	-0.87	-0.87	-0.88	-0.88	-0.87	-0.88	-0.88	-0.88	
Moneyness (K/S)		1.25	1.25	1.24	1.26	1.24	1.26	1.32	1.34	1.40	
Time-to-Maturity (days)		76	74	71	72	68	69	69	68	68	
Spread/S (%)		2.38	2.03	1.85	1.84	1.51	1.77	1.75	1.70	2.00	
Panel C: Using put with the same strike and maturity as the call in the covered-short strategy											
Alpha of long-put		-2.32	-1.33	-1.42	-1.83	-1.41	-1.33	-1.87	-1.44	-0.87	0.62
T-Statistic		-3.94	-4.32	-6.21	-5.51	-7.66	-6.39	-8.14	-5.66	-3.15	3.55
Alpha of uncovered-short minus long-put		1.95	1.57	1.45	1.51	1.25	1.35	1.50	1.43	1.58	0.18
T-Statistic		9.30	17.53	21.42	18.54	26.65	23.37	26.88	21.71	22.49	3.85
Option's average time in portfolio (months)		1.18	1.18	1.19	1.21	1.21	1.19	1.16	1.17	1.19	
Delta		-0.80	-0.81	-0.81	-0.82	-0.82	-0.82	-0.82	-0.82	-0.81	
Moneyness (K/S)		1.17	1.16	1.15	1.16	1.15	1.16	1.18	1.18	1.20	
Time-to-Maturity (days)		87	87	86	85	82	81	75	72	67	
Spread/S (%)		1.87	1.60	1.49	1.47	1.25	1.43	1.37	1.32	1.47	